MONTHLY PROGRESS REPORT
MONTANA DOT "PERFORMANCE PREDICTION MODELS"
AUGUST 2004

To:	**Susan Sillick, MDT; Jon Watson, MDT**
Contract No.:	**MDT HWY-30604-DT**
Contractor:	**Fugro Consultants LP**
Contract Period:	**June 2001-May 2006**
Prepared By:	**Jim Moulthrop, Project Manager**
Date Prepared:	**September 13, 2004**

PROJECT OVERVIEW

The overall objective of this research is to develop a design process and performance/distress prediction models that will enable the Montana Department of Transportation (MDT) to use mechanistic-empirical principles for flexible pavement design. The project involves a comprehensive performance monitoring and laboratory-testing program and spans a period of five years.

The specific tasks identified in the work plan are:

PHASE I
- Task 1. Literature Review
- Task 2. Review of MDT Pavement-Related Data
- Task 3. Establish the Experimental Factorials
- Task 4. Develop Work Plan for Monitoring and Testing

PHASE II
- Task 5. Presentation of Work Plan to MDT
- Task 6. Implement Work Plan – Data Collection
- Task 7. Data Analyses and Calibration of Performance Prediction Models
- Task 8. Final Report and Presentation of Results

NOTE: New information for the current month is notated by double-lines to the left of text, tables, or figures.

CURRENT WORK ACTIVITIES AND COMPLETED TASKS

PHASE I

Task 1 – Literature Review

Completed: The "Literature Review," summarizing the pavement performance models to be considered within this project, was submitted to MDT in October 2001.

Task 2 – Review of MDT Pavement-Related Data

Completed: A review of the available pavement-related data specific to the State of Montana was completed and included in the Task 3 "Experimental Factorial" and Task 4 "Sampling and Testing Plan" submitted to the MDT in October 2001.

Planned: Because the LTPP database is updated periodically, to ensure the data is accurate and current, Fugro will perform a one-time final update of the calibration/validation database before the end of the project.

Task 3 – Establish the Experimental Factorials

Completed: The "Minimum Data Elements" report and the "Experimental Factorial" were completed and submitted to MDT in October 2001. The factorial consists of 93 LTPP test sections of which 38 are in the State of Montana and the remaining 55 in neighboring States and Canada. In addition, 10 non-LTPP, supplemental sites were established and included in the factorial. These sites are: Condon, Deerlodge / Beckhill, Silver City, Roundup, Lavina, Wolf Point, Ft. Belknap, Perma, Geyser, and Hammond.

In March 2004, after a review of the results of the performance prediction analyses available to date, the team decided to include the two tentatively selected Superpave sites, Lothair and Baum Rd., in the group of non-LTPP sites. These sites were selected based on their geographical location and subgrade type in order to cover the whole range of climatic/subgrade conditions specific to Montana.

Task 4 – Develop Work Plan for Monitoring and Testing

Completed: A Work Plan was developed and provided to MDT in October 2001. The document contains the "Materials Sampling Plan," the "Initial Testing Plan" to document the baseline condition of each test site, the "Laboratory Testing Plan" to define the material properties and layer thickness at each test site, and the "Performance Monitoring Plan" to document time series data within the 60-month contract period.

The Performance Monitoring Plan was revised in a team meeting in March 2004 and is presented here:

- *Distress Surveys* Available: June 2002, June 2003; plan for June 2005
- *FWD* Available: August 2001, April 2002; April 2004, plan for March 2005
- *Profile* Available: October 2001; plan for 2004, May 2005

A comparison study was performed on LTPP sections in Great Falls and Big Timber, Montana (May 6-May 19, 2004) in which Montana LTPP sections were tested in parallel with MDT's FWD equipment and LTPP's FWD equipment. The purpose of this comparison testing was to identify any bias that might exist between the FWDs used to measure deflection data on different test sections that will be used on this project. The hypothesis was that there is no bias between the two devices.

FWD testing was completed in May and the comparison analysis was performed this month (August). Deflection data is available at 416 locations (station/lane) for 4 drop heights (load

levels: 6, 9, 12, and 16 kip) and 9 sensors. The LTPP and MTDOT FWD equipment are using the same number of sensors and the same sensor spacing. Plots of deflections measured with the LTPP FWD versus the MDT FWD have been developed for each sensor and drop height (load level). All these plots are included in Appendix A.

The major conclusions of this comparison study are:

- The LTPP equipment consistently measured higher deflections when compared to the MDT equipment, for all sensors and all drop heights; the bias was higher for sensor 1 and decreasing as the distance from the load (sensor 1) increases.
- The bias in the measured deflections appears to be significant; further analysis will investigate the corresponding bias in backcalculated modulus values.
- As illustrated in the plots in Appendix A, the bias is consistent and a correction factor could easily be implemented by using a linear, two parameter equation.
- Further testing is not likely to be necessary.

The effect on backcalculated moduli values will be investigated during the next reporting period. A similar study for Profile equipment is desirable and will be planned.

Task 5 – Presentation of Work Plan to MDT

Completed: The Work Plan (PowerPoint) was presented to MDT by the project team in October 2001.

PHASE II

Task 6 – Implement Work Plan – Data Collection

LTTP SITES
There are 93 LTPP sites included in the experimental factorial. Of these, 38 are located in Montana and 55 in neighboring States and Canada. A set of queries was written that can be used at any time in the future to extract the data needed from the LTPP database to update the information in the calibration/validation database. The database is now complete and populated with LTPP data.

NON-LTPP SITES
The 10 non-LTPP sites are: Condon, Deerlodge / Beckhill, Silver City, Roundup, Lavina, Wolf Point, Ft. Belknap, Perma, Geyser, and Hammond. All testing related to the 10 sites is completed and the results have been presented in previous progress reports.

SUPERPAVE SITES
In addition to the 10 non-LTPP sites, two Superpave sites have been selected to be included in the testing/monitoring plan. These sites are Lothair and Baum Rd. Samples of materials from the two sites have been received from MDOT during 2003 and consist of binder cans, bags of bulk mix and buckets with unbound material. The materials have been stored off site in a temperature controlled storage room.

Binder testing results from Trumbull (Granite City, Illinois) for the three Superpave mixture tests were presented in the May 2004 monthly report. Resilient modulus testing for the unbound materials is underway at Fugro's laboratory in Houston.

NOTE: HMA cores are not available to test for indirect resilient modulus, tensile strength and creep. However, gradation, volumetric properties and viscosity can be used to predict the stiffness of the HMA layer using the "Witczak et al. Dynamic Modulus" predictive equation.

Task 7 – Data Analyses and Calibration of Performance Prediction Models

Completed: The calibration technique (or the specific steps required to determine calibration coefficients) was demonstrated to MDT utilizing models similar in nature to the NCHRP 1-37A *Mechanistic-Empirical (M-E) Pavement Design Guide* (initially titled *2002 Design Guide*) models. The project team made a presentation to the department in August 2003, which included a progress report, findings, and an illustration of the calibration exercise for the Silver City test section. A detailed discussion of the calibration algorithm accompanied by examples and step-by-step instructions will be included in a chapter of the Final Report.

On Tuesday, August 24, a project meeting update and status report was held at MDT's headquarters. An overview of the work completed to date and a presentation on the calibration process as well as the results obtained to date were presented. A demonstration of the new *M-E Pavement Design Guide* software was provided to identify the complexity, detail of the inputs, and note some of the problems that will likely be encountered by the Department personnel in using the software for selected pavement types. The agenda and notes from the meeting are included in Appendix B.

The calibration and validation database has been finalized and populated with LTPP data. The latest version of the calibration/validation database was given to MDT (CD format) at the August 24, 2004 meeting.

An initial performance prediction exercise was performed for the 10 non-LTPP experimental sites. Material test data together with historical traffic and climatic data were used to predict the performance of these sites in terms of fatigue cracking and rutting in the asphalt concrete layer and rutting in the base and subgrade layers. Predicted distress was compared to results of the two distress surveys available for these sites (June 2002 and June 2003) and to the rutting measurements taken in October 2001. The results of this exercise were included in the July-September 2003 Quarterly Report.

A second performance prediction analysis, similar to the one performed on the non-LTPP, was started on the LTPP experimental sites. The availability of LTPP data was investigated in parallel with this study. While the performance predictions could be done either by spreadsheets or using the M-E Design Guide software, the solution by spreadsheets was used primarily because the Design Guide software is not yet available. However, after a review and revision of the project budget this month, the study was suspended. The team considers that the performance predictions that will be performed using the M-E Design Guide software are of greater importance and the funds available will be allocated to this effort.

The review edition of the M-E Design Guide software was released by NCHRP mid-July. The research team used the software to begin the calibration analyses for the performance models included in the M-E Design Guide.

The project team will complete a simplified calibration exercise using the same distress prediction models, but in a more simplified manner so that MDT can use this information with their pavement management database. This activity will be demonstrated to MDT during the final meeting and will be included in the final report submitted for review.

Task 8 – Final Report and Presentation of Results

No activity.

PROBLEMS / RECOMMENDED SOLUTIONS

No problems were encountered during last month and none are anticipated next month.

NEXT MONTH'S WORK PLAN

The activities planned for next month are listed below:

- Coordinate with MDT personnel on an as-needed basis.
- Continue the analysis of FWD testing data from Great Falls and Big Timber, Montana.
- Analyze resilient modulus test results for Lothair and Baum Rd

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FINANCIAL STATUS

The Financial Summary I table shows the estimated expenses incurred during the reporting period.

The Financial Summary II table provides the total project expenditures by the Montana and FHWA fiscal years in comparison to the allocated funds for each fiscal year.

The Financial Summary III-A chart illustrates total expenditures from inception of the project June 2000 through December 2003. The Financial Summary III-B chart reflects total project expenditures from January 2004 to the end of the project, May 2006.

cc: Jim Moulthrop, Fugro
Dragos Andrei, Fugro
Amber Yau, Fugro
Veena Prabhakar, Fugro
Harold Von Quintus, ERES/ARA
Jon Watson, MDT
Greg Zeihen, MDT
Matthew Witczak, Consultant
Mark Hallenbeck, Consultant

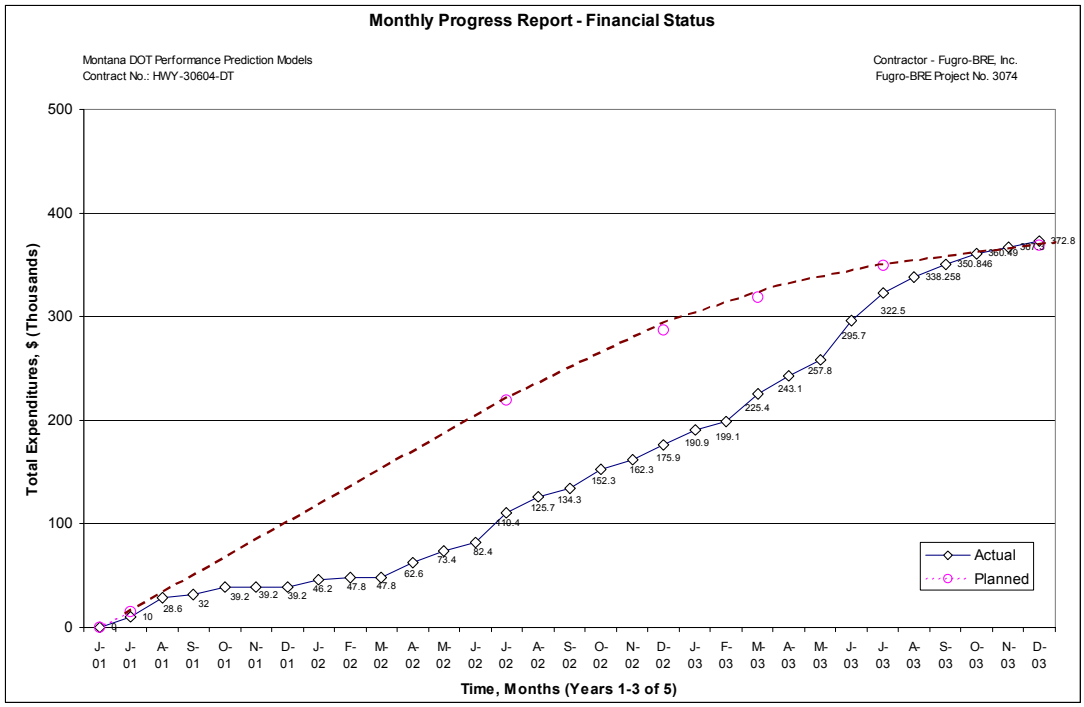
Financial Summary I
Estimated Expenses for Reporting Period: Fugro-BRE

Cost Element	Last Month's Cumulative Project Costs, $	Current Month's Expenditures, $	Cumulative Project Costs, $
Direct Labor	$ 99,363.35	1,673	101,036
Overhead	142,089.48	2,392	144,481
Consultants/Subcontractors	51,015.74	2,561	53,577
ERES/ARA	31,220.04	-	31,220
Parsons-Brinckerhoff	12,092.58	-	12,093
SME	523.21	-	523
Dr. Matthew Witczak	2,850.00	-	2,850
Dr. Mark Hallenbeck	3,129.91	2,561	5,691
Dr. Brent Rauhut	1,200.00	-	1,200
Travel	14,607.23	-	14,607
Testing	73,849.58	1,615	75,465
Other Direct Costs	6,838.61	108	6,947
Fee	38,349.67	579	38,928
TOTAL	$ 426,113.66	8,927	435,041

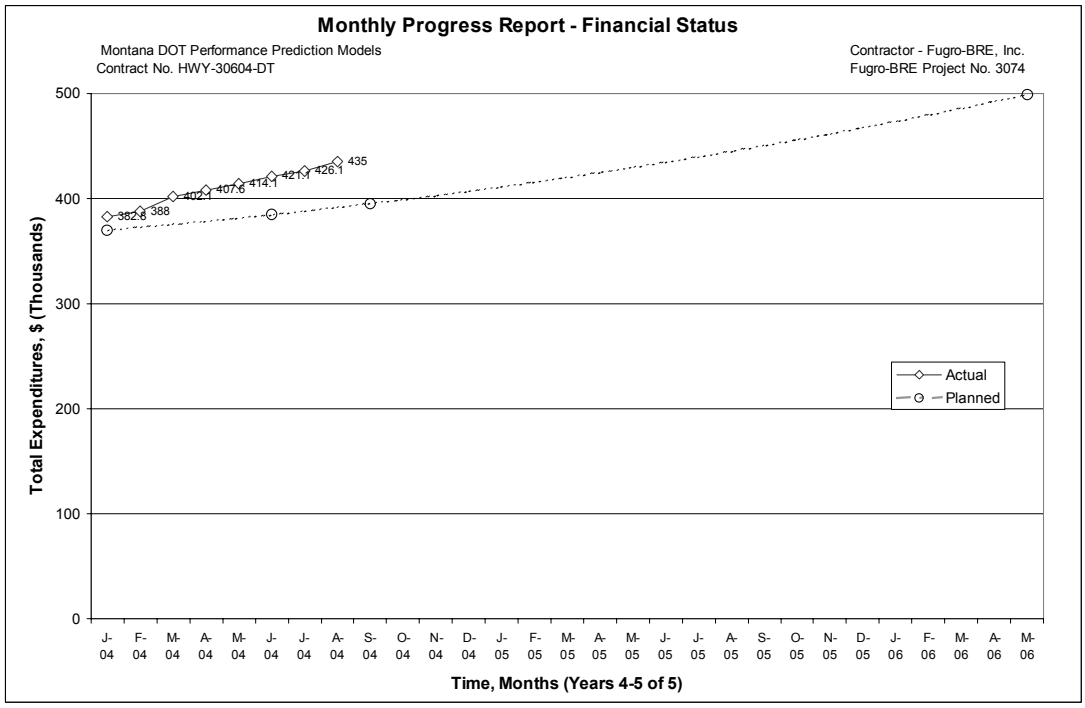
Financial Summary II
Total Expenditures by Fiscal Year: Montana and FHWA

MONTANA DOT FISCAL YEAR			**FHWA FISCAL YEAR**		
Fiscal Year	Cumulative Allocated Funds, $	Cumulative Expenditures, $	Fiscal Year	Cumulative Allocated Funds, $	Cumulative Expenditures, $
6/1/2000-6/30/**2001**	15,000	*0	6/1/2000-9/30/**2001**	65,000.00	31,996
7/1/2001-6/30/**2002**	218,969	82,420	10/1/2001-9/30/**2002**	258,969.00	102,303
7/1/2002-6/30/**2003**	348,969	213,291	10/1/2002-9/30/**2003**	358,969.00	216,187
7/1/2003-6/30/**2004**	388,969	125,486	10/1/2003-9/30/**2004**	398,969.00	84,556
7/1/2004-6/30/**2005**	428,969	13,845	10/1/2004-9/30/**2005**	438,969.00	0
7/1/2005-6/30/**2006**	498,969	0	10/1/2005-9/30/**2006**	498,969.00	0
TOTAL	498,969	435,042	TOTAL	498,969.00	435,042

*June 2001 expenditures were combined with July 2001 expenditures.



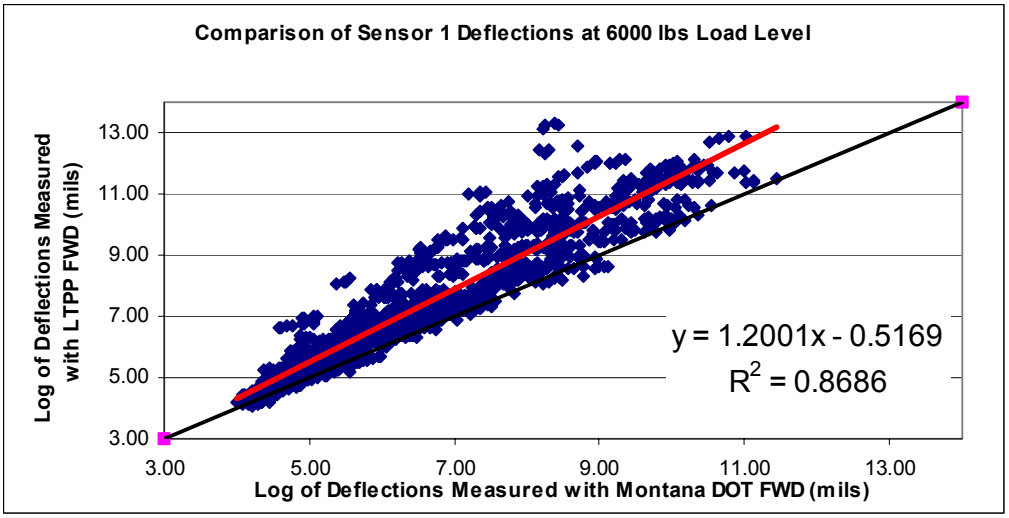
Financial Summary III-A: Total Expenditures by Month Jun 2000 – Dec 2003

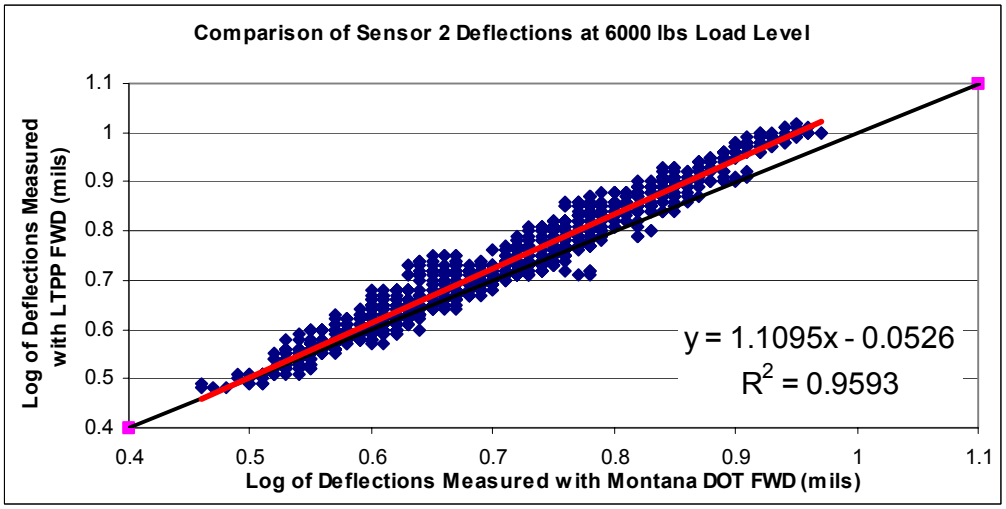


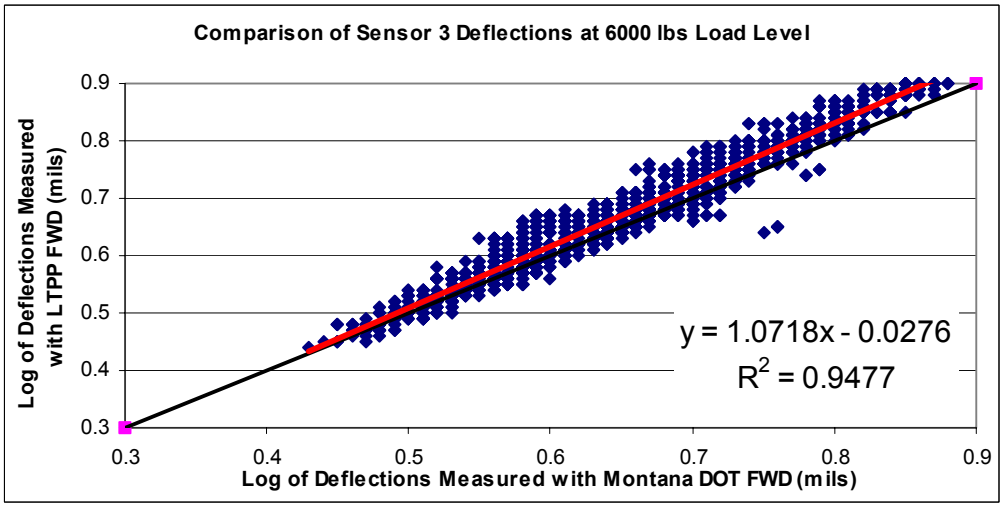
Financial Summary III-B: Total Expenditures by Month Jan 2004 – May 2006

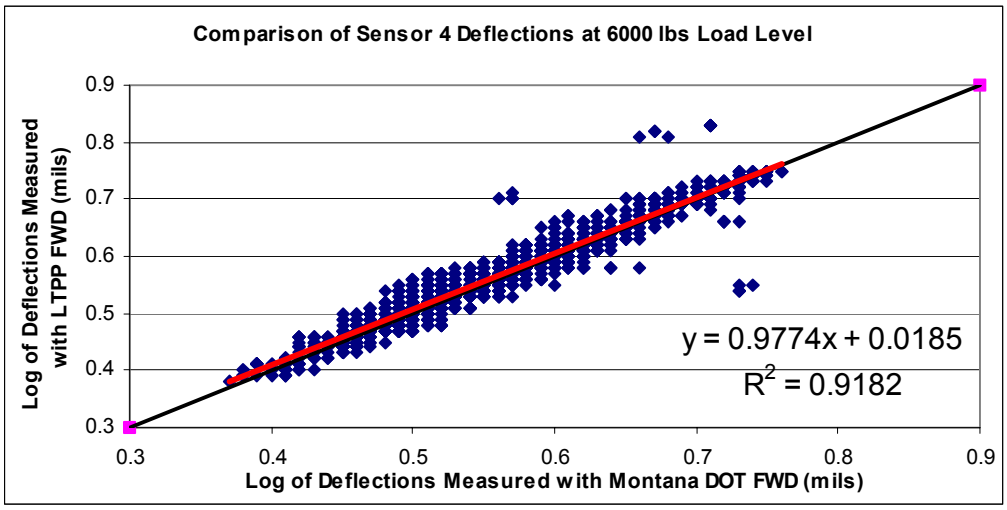
APPENDIX A FWD COMPARISON STUDY DEFLECTIONS

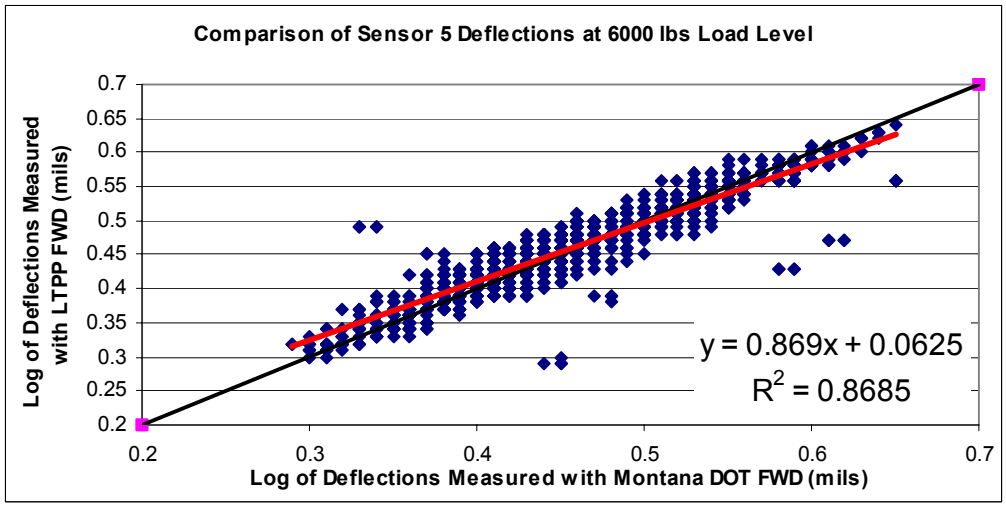
6 KIP

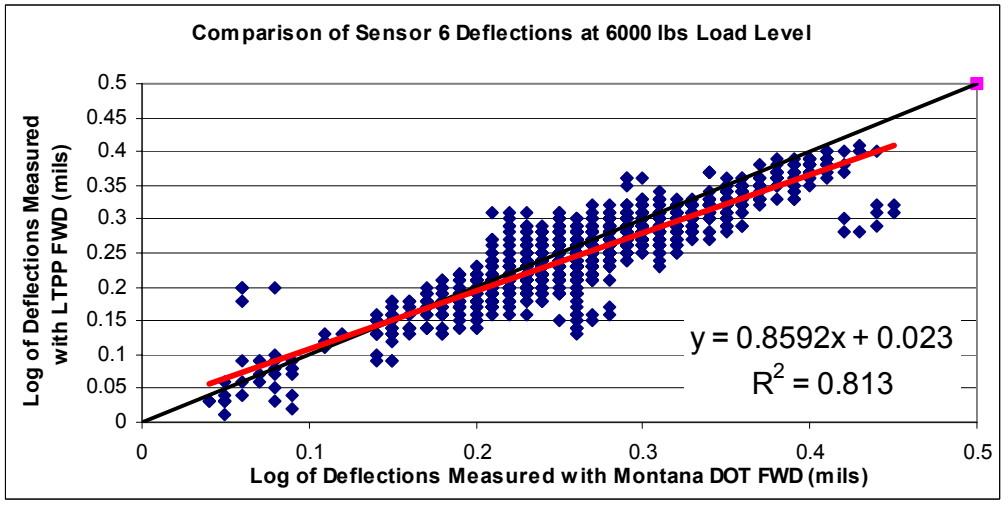

Comparison of Sensor 1 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
13.00
11.00
9.00
7.00
5.00
3.00
3.00
5.00
7.00
9.00
11.00
13.00
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.2001x - 0.5169
R2 = 0.8686

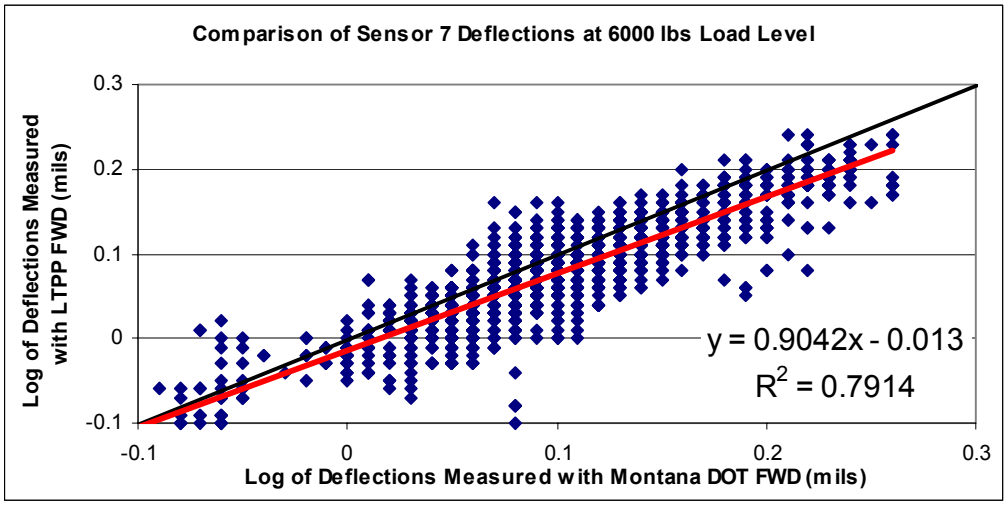

Comparison of Sensor 2 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.1095x - 0.0526
R2 = 0.9593

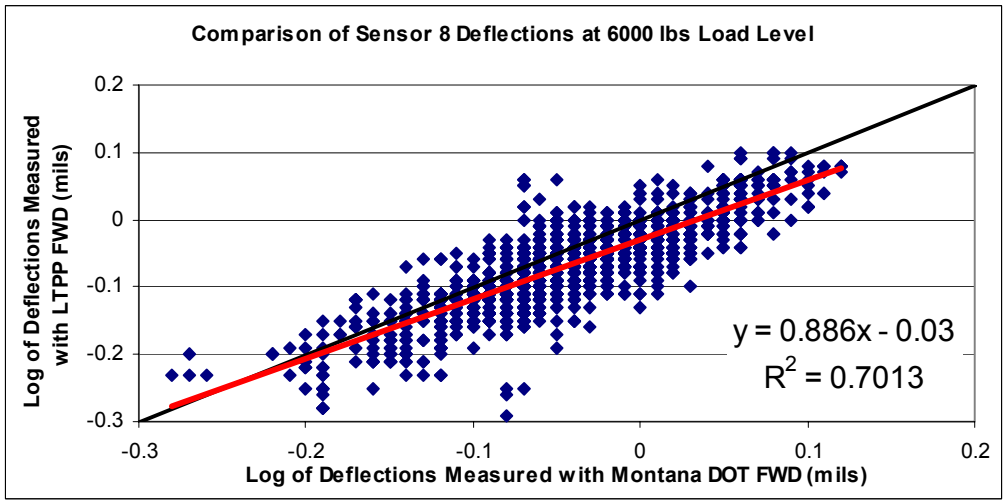

Comparison of Sensor 3 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0718x - 0.0276
R2 = 0.9477

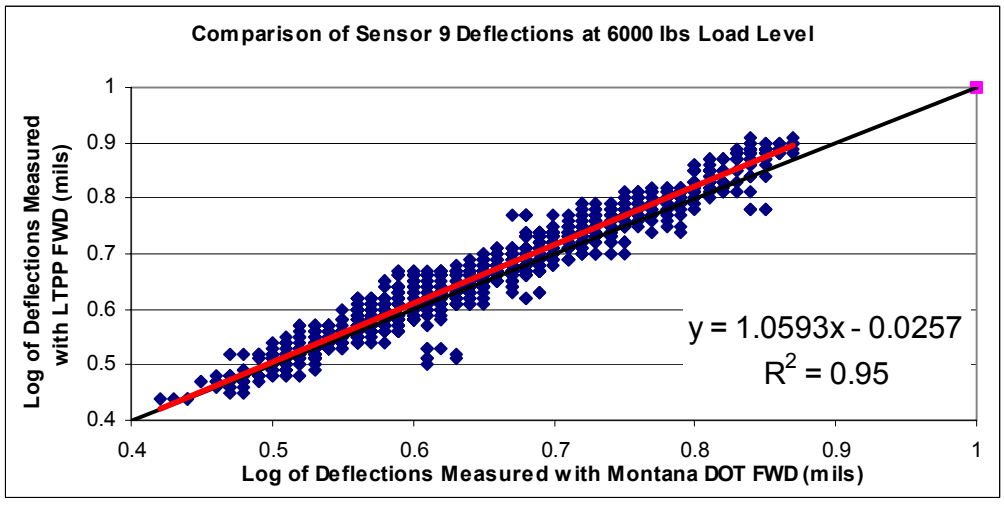

Comparison of Sensor 4 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9774x + 0.0185
R2 = 0.9182
0.3
0.4
0.5
0.6
0.7
0.8
0.9


Comparison of Sensor 5 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.869x + 0.0625
R2 = 0.8685
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7

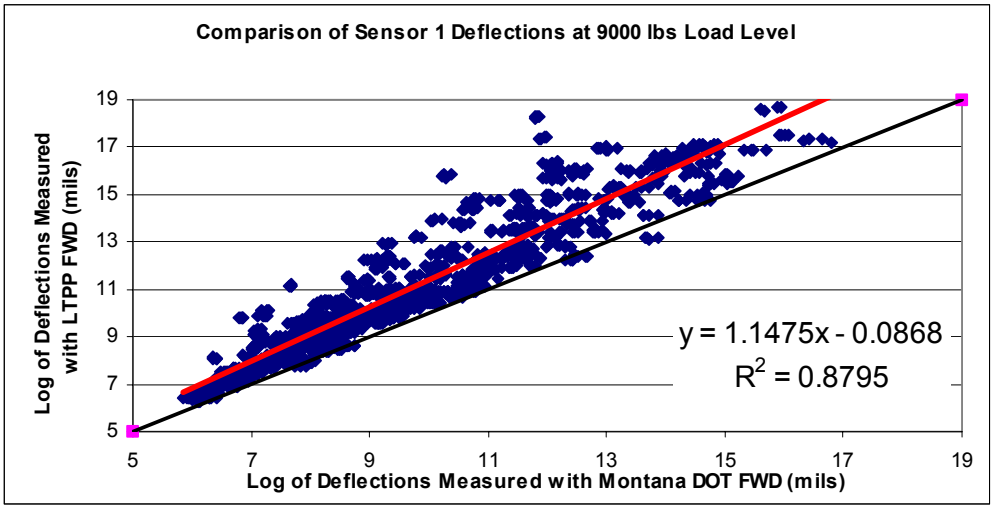

Comparison of Sensor 6 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8592x + 0.023
R2 = 0.813
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

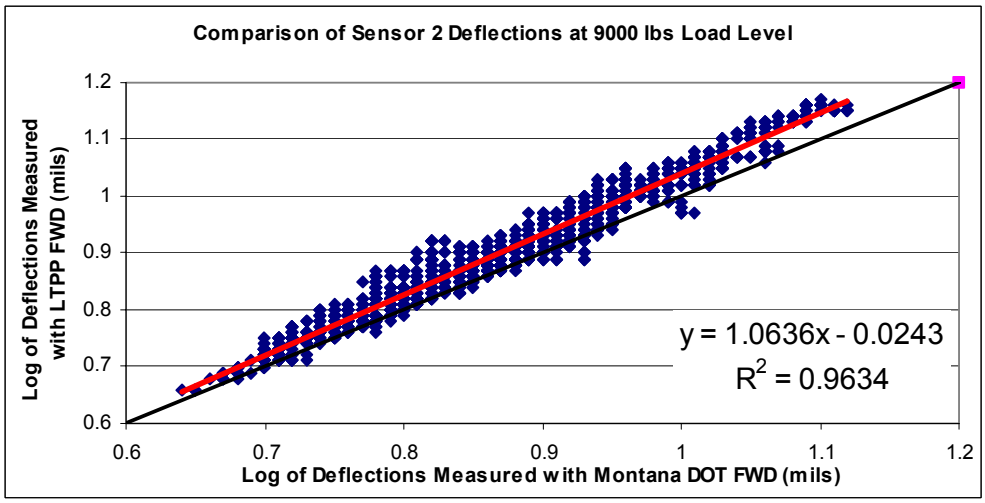

Comparison of Sensor 7 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9042x - 0.013
R2 = 0.7914
0.3
0.2
0.1
0
-0.1
-0.1
0
0.1
0.2
0.3

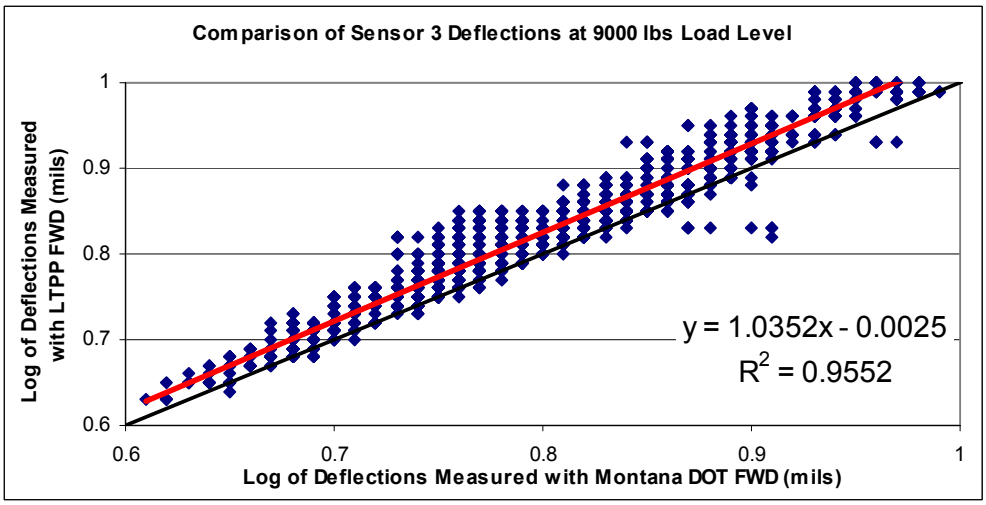

Comparison of Sensor 8 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.886x - 0.03
R2 = 0.7013
0.2
0.1
0
-0.1
-0.2
-0.3
-0.3
-0.2
-0.1
0
0.1
0.2

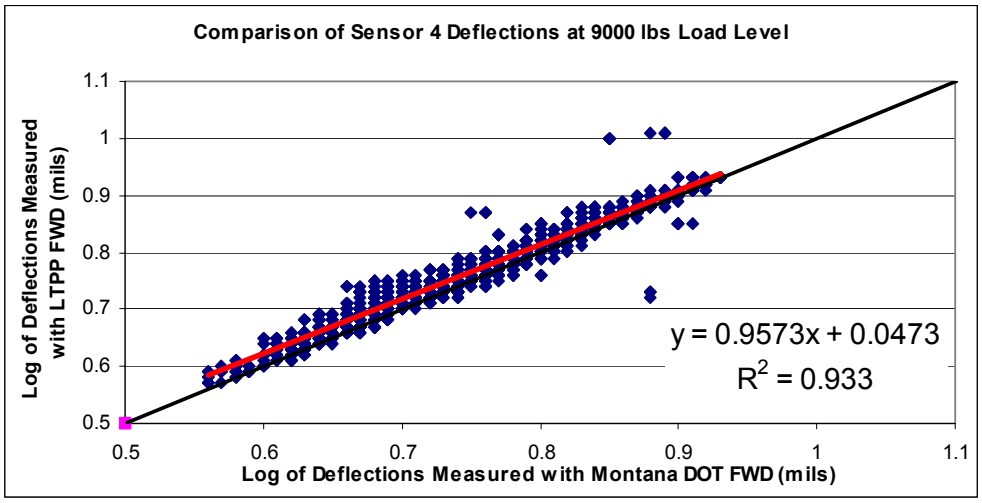

Comparison of Sensor 9 Deflections at 6000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0593x - 0.0257
R2 = 0.95
1
0.9
0.8
0.7
0.6
0.5
0.4
0.4
0.5
0.6
0.7
0.8
0.9
1

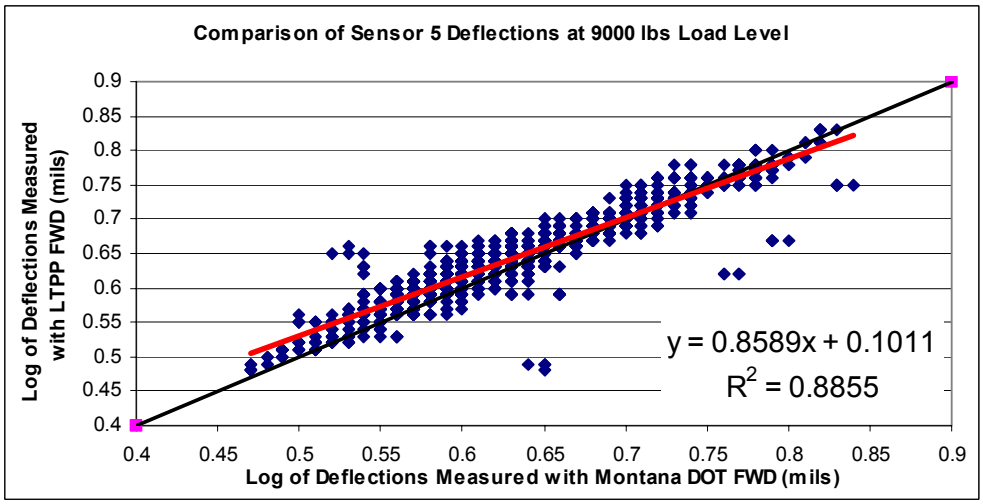
9 KIP

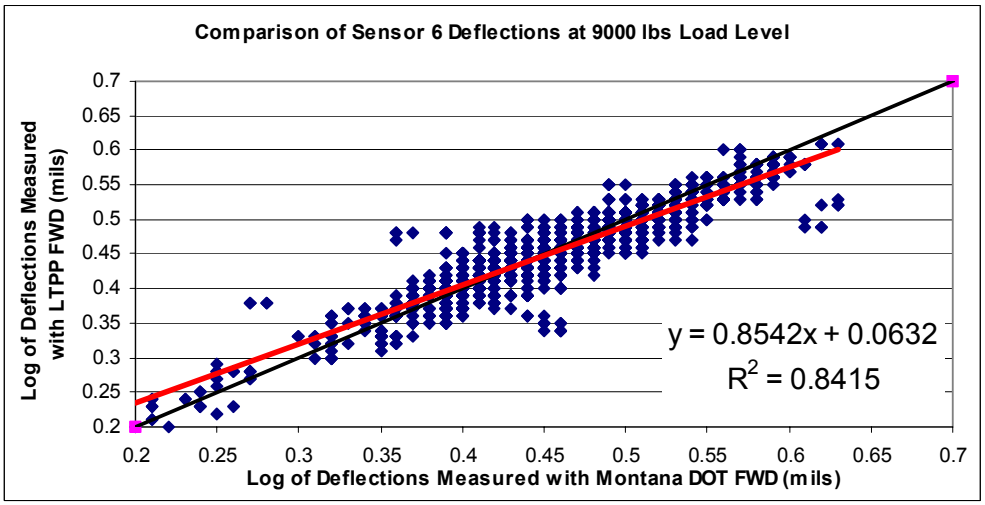

Comparison of Sensor 1 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.1475x - 0.0868
R2 = 0.8795
5
7
9
11
13
15
17
19

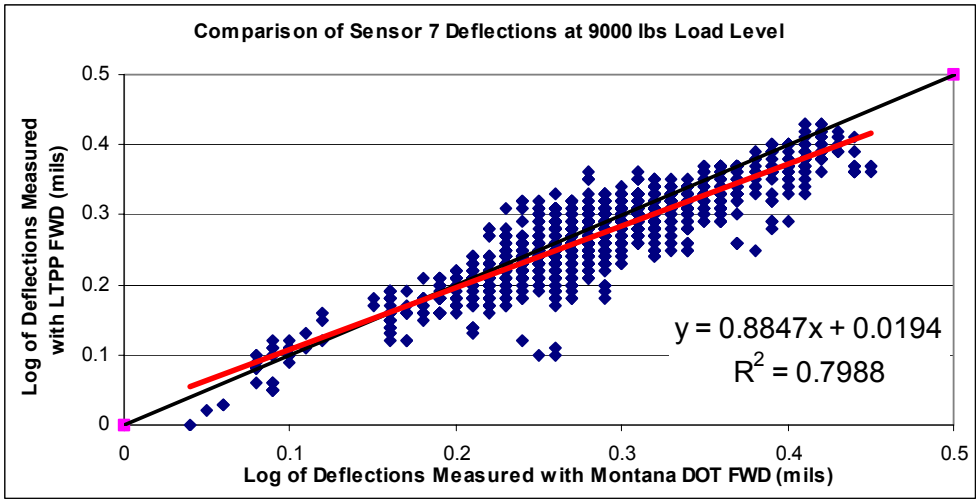

Comparison of Sensor 2 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0636x - 0.0243
R2 = 0.9634
0.6
0.7
0.8
0.9
1
1.1
1.2

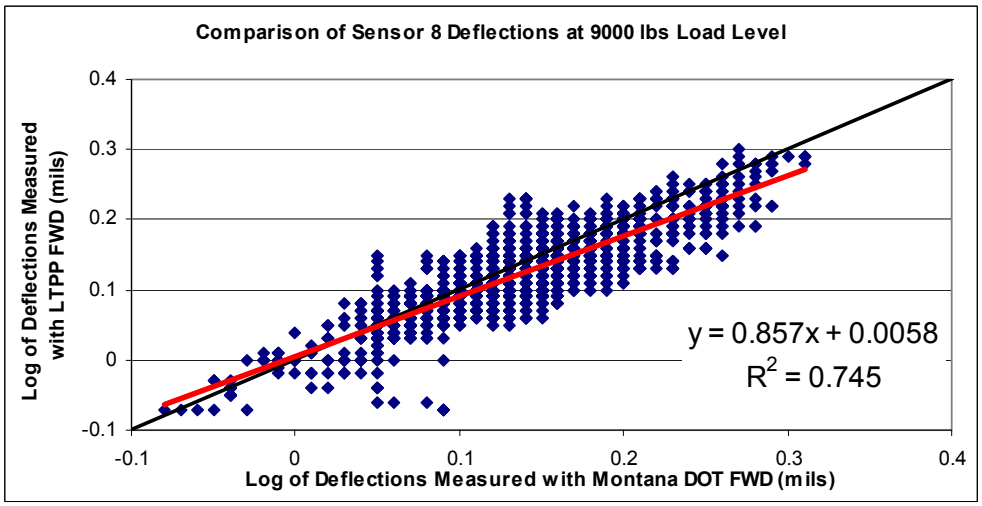

Comparison of Sensor 3 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0352x - 0.0025
R2 = 0.9552
0.6
0.7
0.8
0.9
1

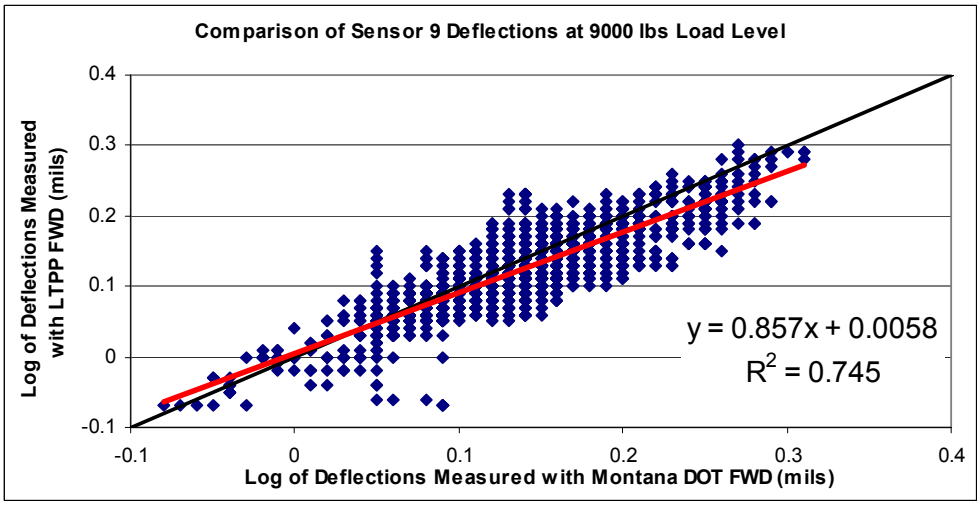

Comparison of Sensor 4 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9573x + 0.0473
R2 = 0.933
1.1
1
0.9
0.8
0.7
0.6
0.5
0.5
0.6
0.7
0.8
0.9
1
1.1


Comparison of Sensor 5 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8589x + 0.1011
R2 = 0.8855
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9

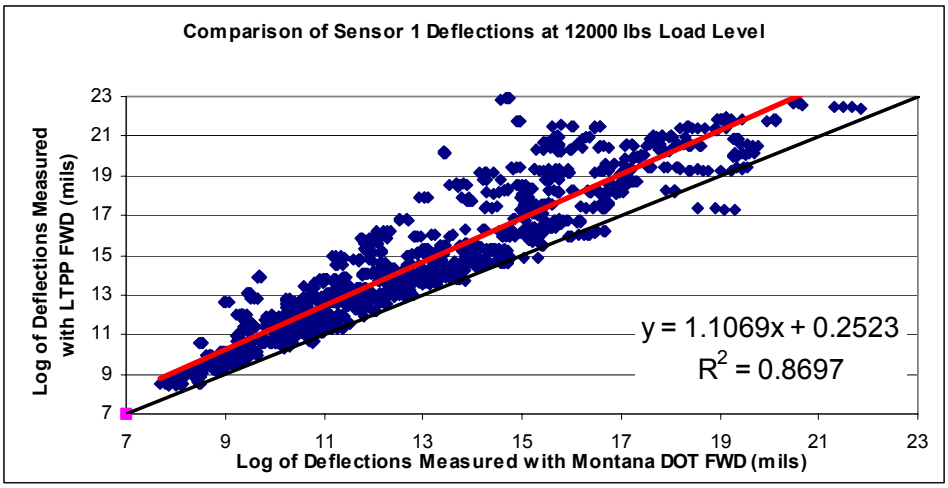

Comparison of Sensor 6 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8542x + 0.0632
R2 = 0.8415
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7

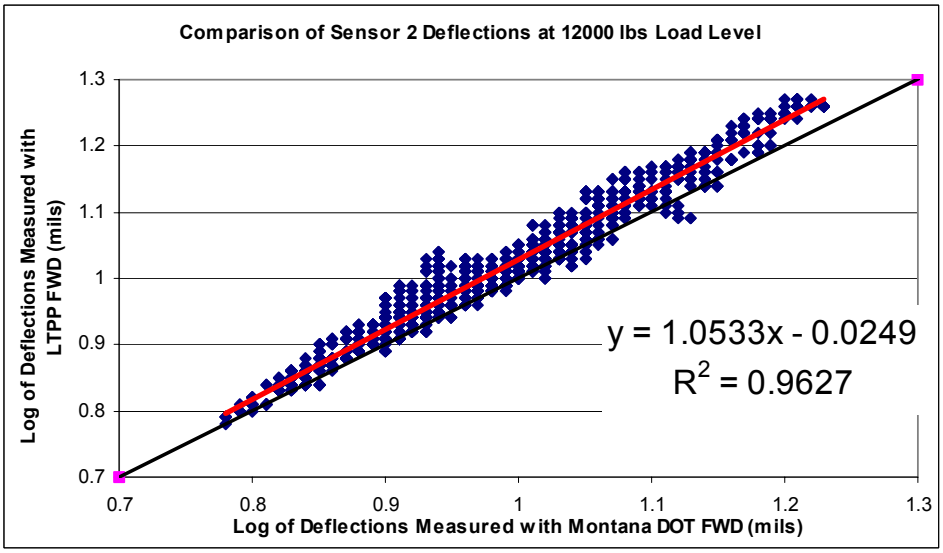

Comparison of Sensor 7 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8847x + 0.0194
R2 = 0.7988
0
0.1
0.2
0.3
0.4
0.5

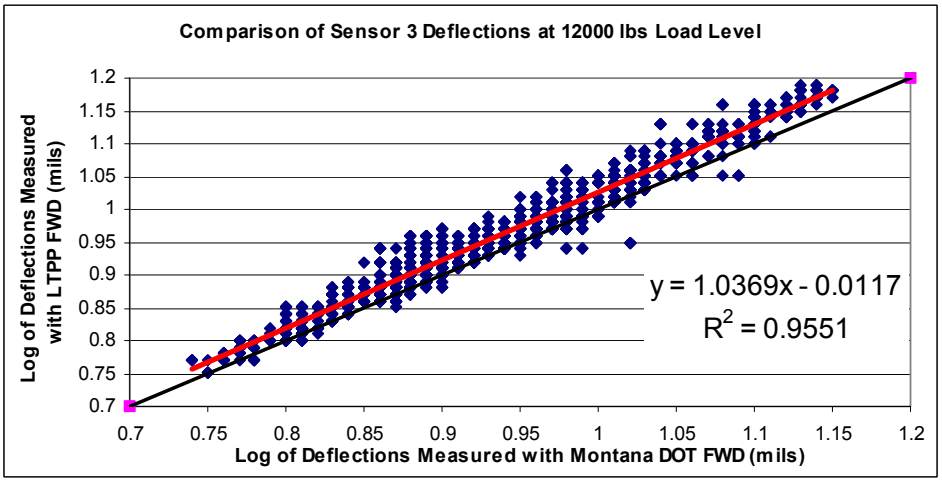

Comparison of Sensor 8 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.857x + 0.0058
R2 = 0.745
-0.1
0
0.1
0.2
0.3
0.4

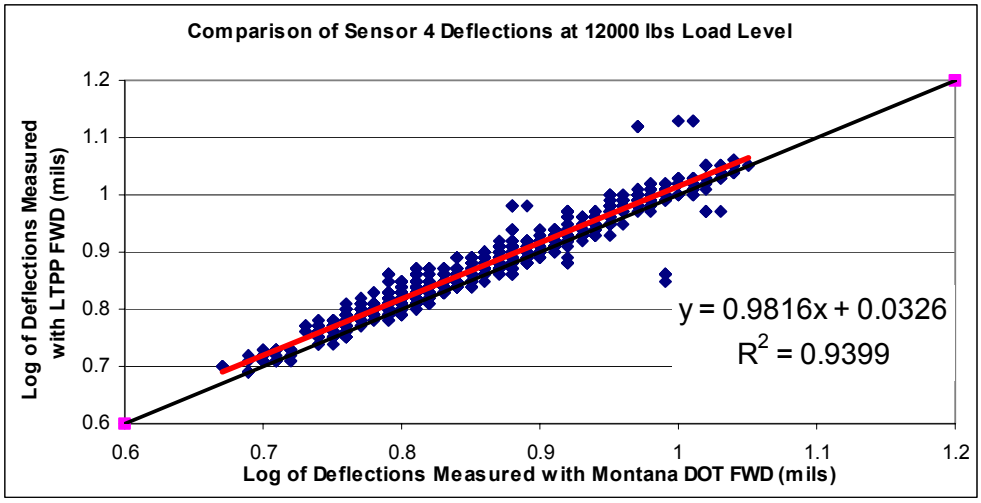

Comparison of Sensor 9 Deflections at 9000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.857x + 0.0058
R2 = 0.745
-0.1
0
0.1
0.2
0.3
0.4

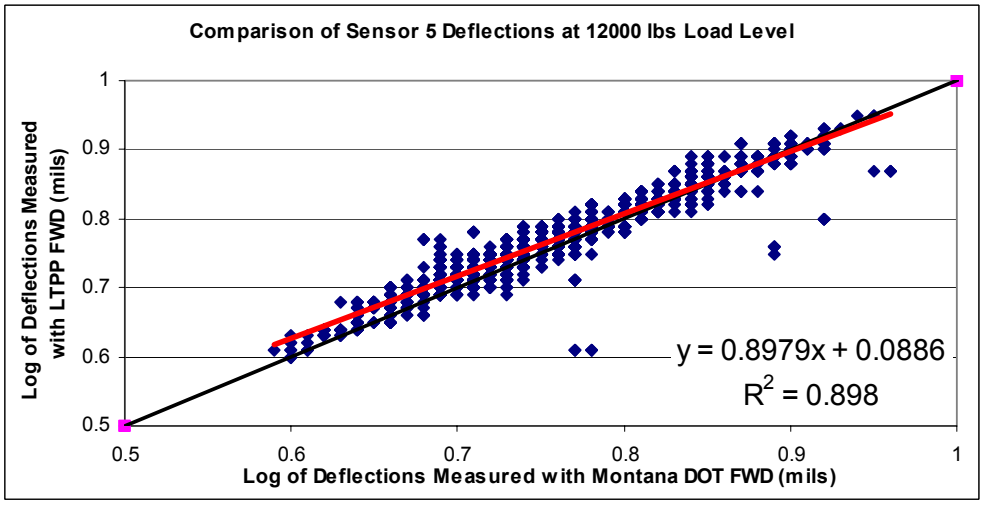
12 KIP

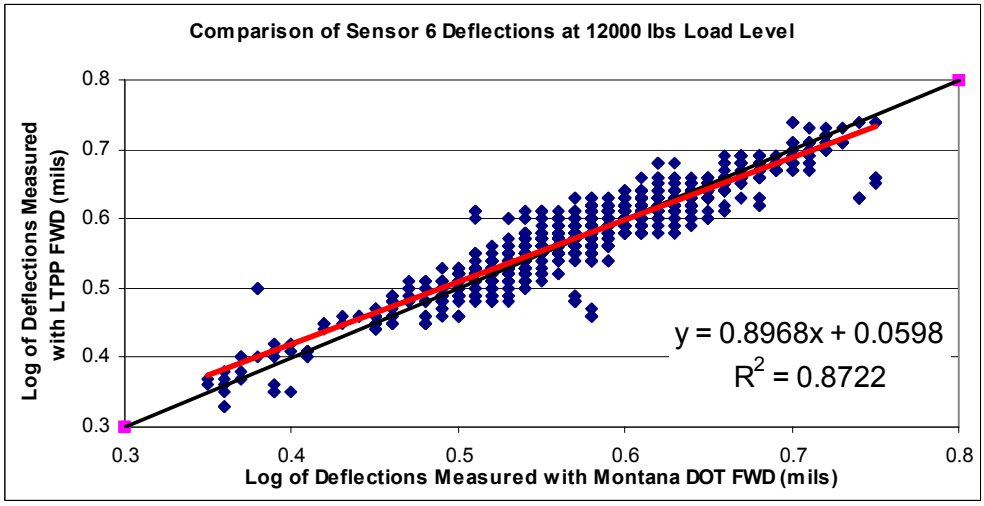

Comparison of Sensor 1 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.1069x + 0.2523
R2 = 0.8697
7
9
11
13
15
17
19
21
23

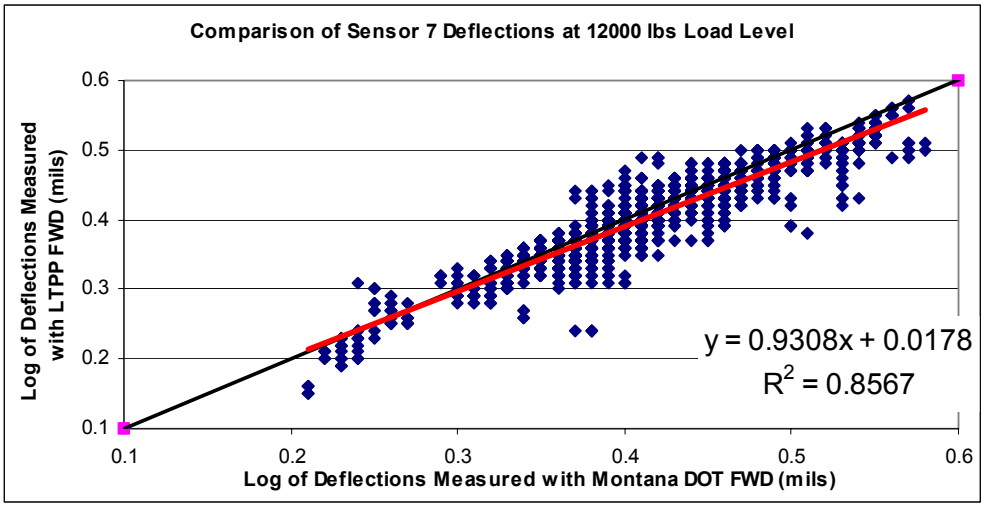

Comparison of Sensor 2 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0533x - 0.0249
R2 = 0.9627
0.7
0.8
0.9
1
1.1
1.2
1.3

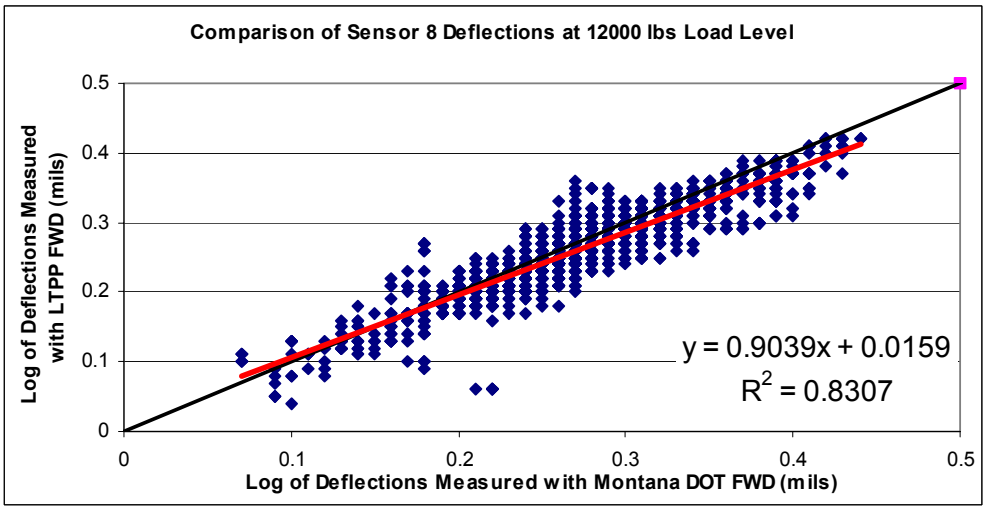

Comparison of Sensor 3 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0369x - 0.0117
R2 = 0.9551
0.7
0.75
0.8
0.85
0.9
0.95
1
1.05
1.1
1.15
1.2

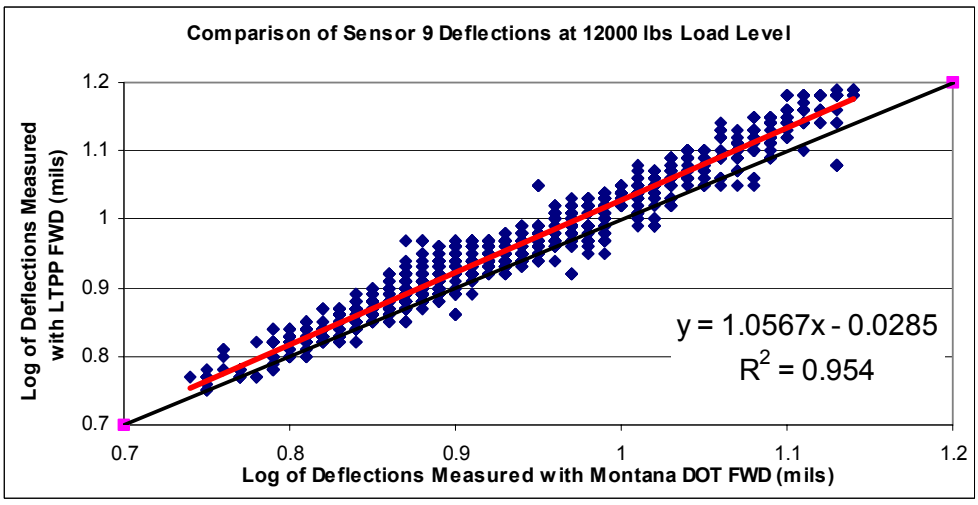

Comparison of Sensor 4 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9816x + 0.0326
R2 = 0.9399
1.2
1.1
1
0.9
0.8
0.7
0.6
0.6
0.7
0.8
0.9
1
1.1
1.2


Comparison of Sensor 5 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8979x + 0.0886
R2 = 0.898
1
0.9
0.8
0.7
0.6
0.5
0.5
0.6
0.7
0.8
0.9
1

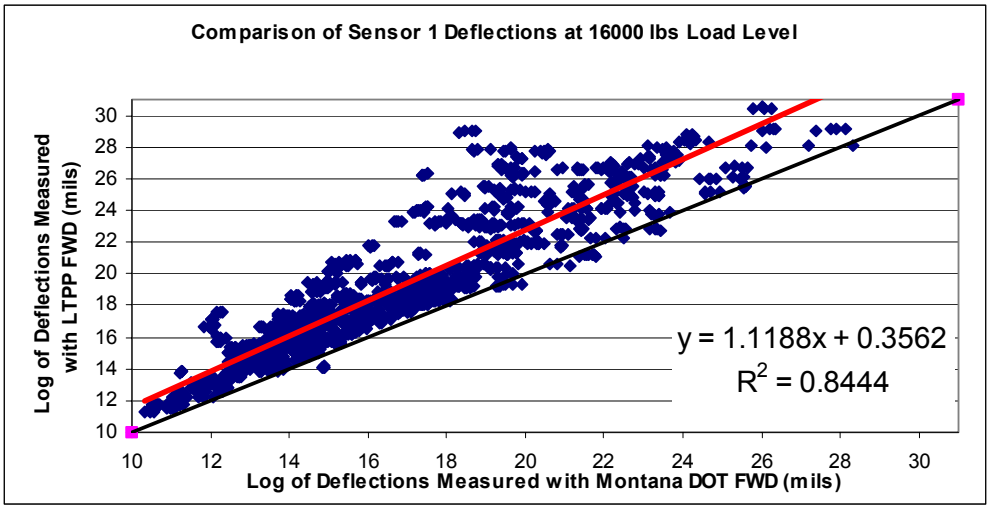

Comparison of Sensor 6 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8968x + 0.0598
R2 = 0.8722
0.8
0.7
0.6
0.5
0.4
0.3
0.3
0.4
0.5
0.6
0.7
0.8

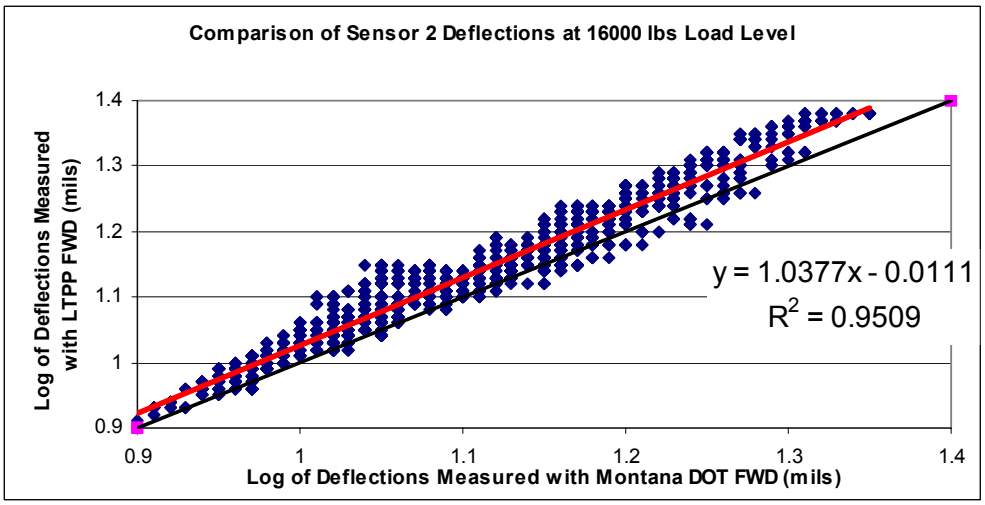

Comparison of Sensor 7 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9308x + 0.0178
R2 = 0.8567
0.1
0.2
0.3
0.4
0.5
0.6

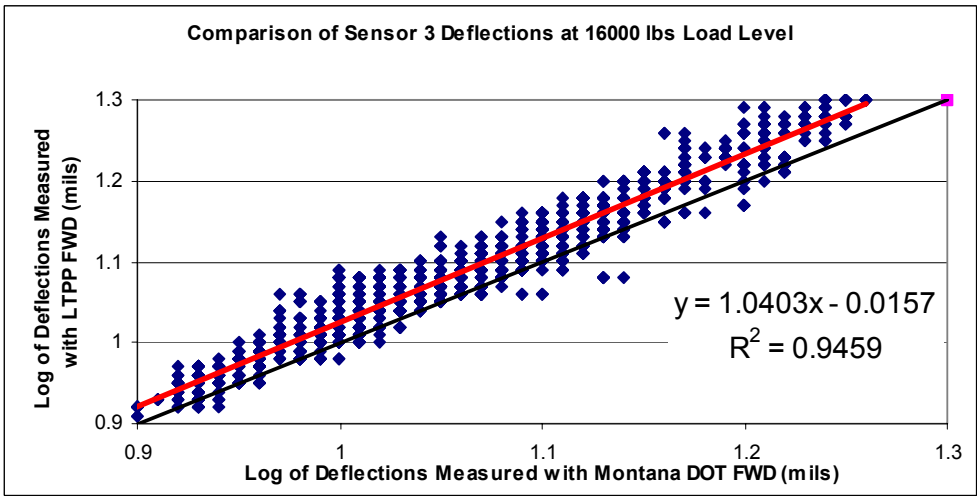

Comparison of Sensor 8 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9039x + 0.0159
R2 = 0.8307
0
0.1
0.2
0.3
0.4
0.5

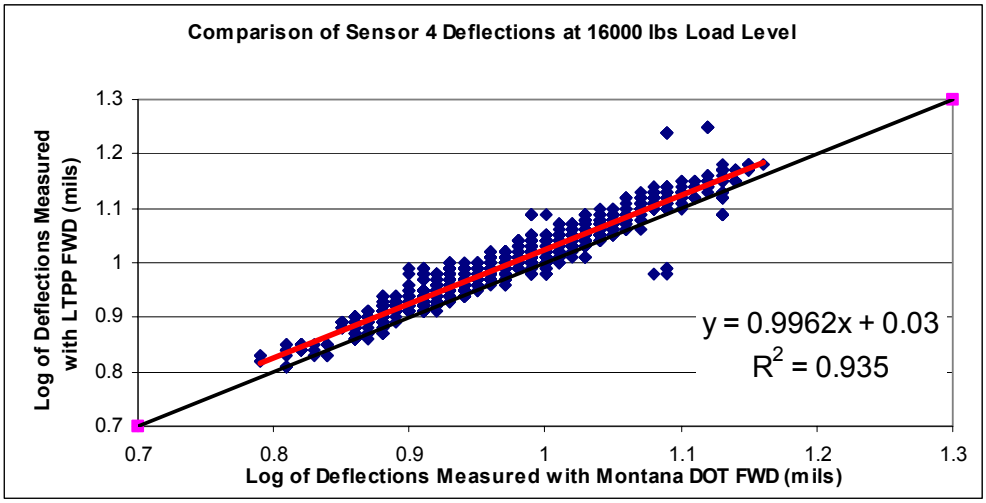

Comparison of Sensor 9 Deflections at 12000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0567x - 0.0285
R2 = 0.954
0.7
0.8
0.9
1
1.1
1.2

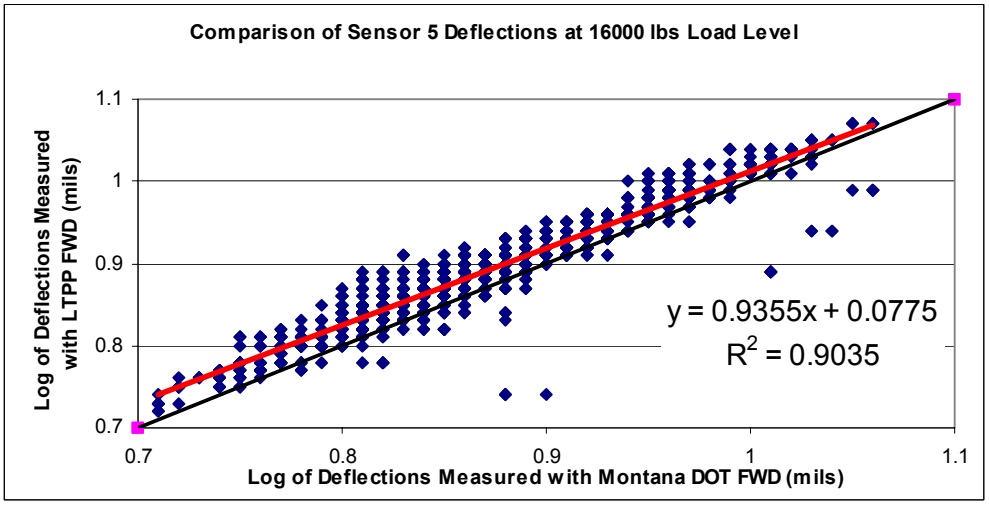
16 KIP

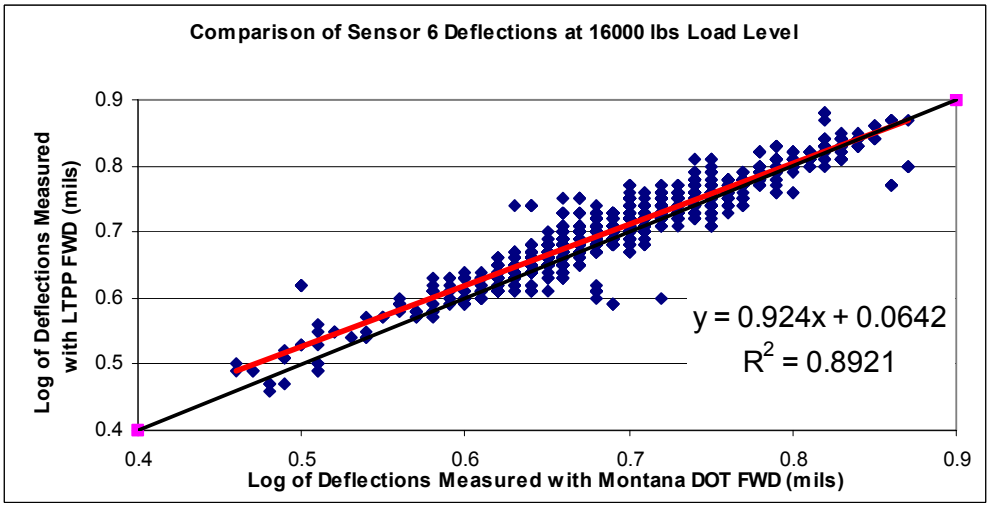

Comparison of Sensor 1 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.1188x + 0.3562
R2 = 0.8444
10
12
14
16
18
20
22
24
26
28
30

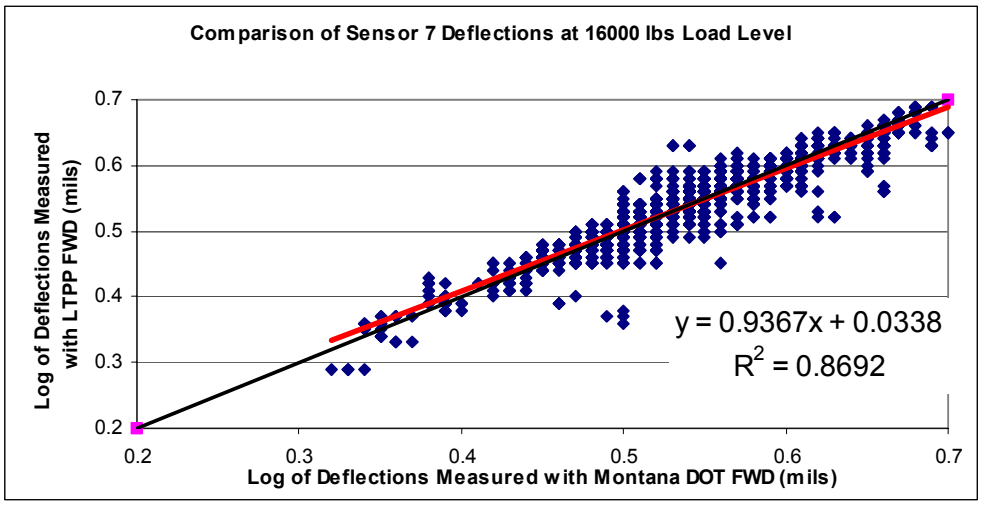

Comparison of Sensor 2 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0377x - 0.0111
R2 = 0.9509
0.9
1
1.1
1.2
1.3
1.4

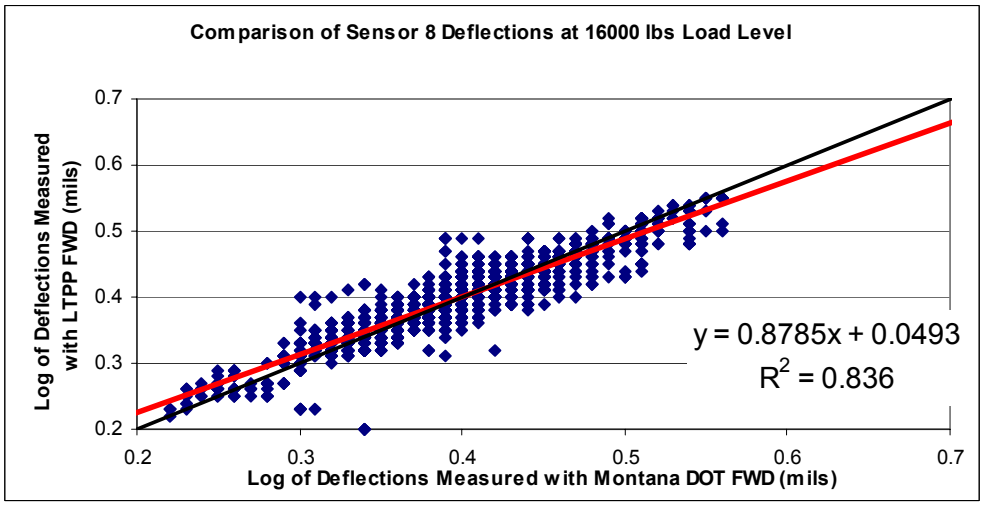

Comparison of Sensor 3 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.0403x - 0.0157
R2 = 0.9459
0.9
1
1.1
1.2
1.3

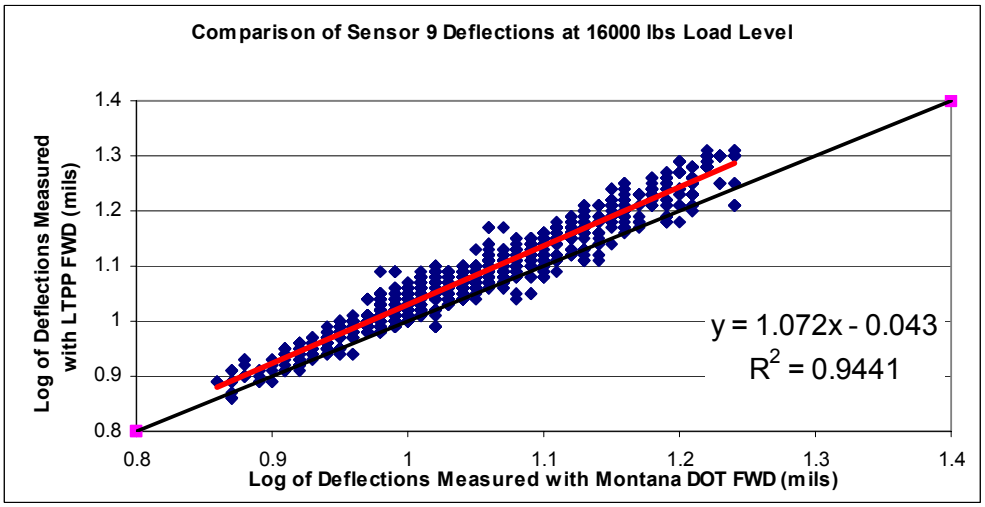

Comparison of Sensor 4 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9962x + 0.03
R2 = 0.935
1.3
1.2
1.1
1
0.9
0.8
0.7
0.7
0.8
0.9
1
1.1
1.2
1.3


Comparison of Sensor 5 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9355x + 0.0775
R2 = 0.9035
1.1
1
0.9
0.8
0.7
0.7
0.8
0.9
1
1.1


Comparison of Sensor 6 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.924x + 0.0642
R2 = 0.8921
0.9
0.8
0.7
0.6
0.5
0.4
0.4
0.5
0.6
0.7
0.8
0.9


Comparison of Sensor 7 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.9367x + 0.0338
R2 = 0.8692
0.2
0.3
0.4
0.5
0.6
0.7


Comparison of Sensor 8 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 0.8785x + 0.0493
R2 = 0.836
0.2
0.3
0.4
0.5
0.6
0.7


Comparison of Sensor 9 Deflections at 16000 lbs Load Level
Log of Deflections Measured with LTPP FWD (mils)
Log of Deflections Measured with Montana DOT FWD (mils)
y = 1.072x - 0.043
R2 = 0.9441
0.8
0.9
1
1.1
1.2
1.3
1.4

APPENDIX B 24 AUGUST 2004 MEETING NOTES

Project Title: Performance Prediction Models August 20, 2004
Project No.: HWY-30604-DT

MEETING AGENDA
August 24, 2004

Meeting Purpose: Project Update and Briefing
Team Members: Dragos Andrei
Harold L. Von Quintus
MDT Staff: Susan Sillick, John Watson, Greg Zeihen, Jody Bachini, Ed Shea

I. Introductions
   a. *Agenda – Suggested Changes or Modifications in Time*

II. Overview and Status of Activities
   a. *Laboratory Testing*
   b. *Field Investigations*
   c. *Database*
   d. *Modeling Calibration-Validation*
   e. *Documentation*

III. Database Overview
   a. *Missing Data Elements – Request LTPP to obtain data*
   b. *Traffic, Material Properties for SPS Projects*

IV. Calibration-Validation Study
   a. *Fatigue Cracking and Rutting*
   b. *Comparison of distress observations and predictions*
   c. *Integration of distress predictions for design and Pavement Management*

V. Demonstration of M-E Pavement Design Guide Software
   a. *Application of Products*

VI. Project Products and Product Submission
   a. *Research Report*
   b. *Calibration Database*
   c. *Interim Task Reports*

VII. What's Left in Project

VIII. Questions and Discussions

Meeting Notes and Action Items

A project meeting update and status report was held on Tuesday, August 24 in the Commission Conference room. The attached agenda lists the items presented and discussed. The meeting started at about 9AM with an overview of the work completed to date.

In summary, a presentation was also provided on the calibration process and the results obtained to date were presented. A demonstration of the new M-E Pavement Design Guide software was provided to identify the complexity, detail of the inputs, and note some of the problems that will likely be encountered by the Department personnel in using the software for selected pavement types. The following is a summary of the items discussed during the project update and status report given to the Montana Department of Transportation on August 24, 2004.

1. There is an FHWA discussion group on the Mechanistic-Empirical Pavement Design Guide. A web site has been created that agencies can go to for asking questions about the new Design Guide. It was suggested that the Department check and use this web site in starting to implement and use the new software.
    a. ***ACTION ITEM:*** ***Dragos will email the link to Greg.***

2. MDT is interested in coordinating with NCAT for future "advanced" asphalt testing (e.g. dynamic modulus and indirect tensile creep compliance testing). MDT will contact NCAT. The person to contact at NCAT is Doug Hanson. It was suggested that MDT request indirect tensile testing to support the thermal cracking part of the new M-E Pavement Design Guide. Much more thermal cracking was predicted than measured for the sites evaluated and analyzed to date. Using actual material properties of the HMA might reduce the bias that has been found to date, when using the level 3 inputs for the thermal cracking predictions.
    a. ***ACTION ITEM:*** ***MDT will contact Doug Hanson at NCAT to determine whether testing can be completed on selected projects form Montana.***

3. A new set of profile data was collected in August 2004.
    a. ***ACTION ITEM:*** ***MDT will send the data to Fugro.***

4. During the presentation, MDT was asked whether those tables with little to no data should be deleted from the calibration database. Some of this missing data in the LTPP database may or may not be obtained with time. After some discussion, it was decided that the tables in the calibration database that contain very little or no data will not be deleted. MDT has hopes that some of the data will be found. The tables will be updated at a later time, when the data becomes available in the LTPP database. As part of the final product, the project team will identify those tables in the calibration database that have been populated with little data. This issue should be addressed near the end of the project.
    a. ***ACTION ITEM:*** ***Include this item in the next project briefing and status update.***

5. As part of the calibration process, the research team will provide not only calibrated coefficients or functions for the performance models included in the M-E Pavement Design Guide software, but also recommended default values for the design inputs (e.g. default resilient modulus values for level 3 inputs). Some of the global default values included in

the Design Guide software may not be appropriate for the materials encountered in Montana. Determination of the recommended default values to be used with the level 3 inputs will be included in the final user's manual being prepared for Montana in implementing the M-E Pavement Design Guide software.

6. MDT noted that there may be an error in the units in one of the slides in comparing the temperatures for the deflection basin comparison study recently completed between the Montana and LTPP units.
    a. ***ACTION ITEM:*** ***Dragos will correct and check the units for temperature in the plots developed for the FWD comparison study.***

7. During the presentation, examples of predicted versus measured rut depths and fatigue cracking were provided primarily for the Montana SPS-1 site. During this discussion on the distress comparisons, it was noted that the HMA might be stripping or have moisture damage. The team noted that they will develop individual site reports that will include inputs, predicted performance and comments specific to each site (e.g. anomalies which may be explained by factors not taken into account in design/analysis) – as an example, stripping or moisture damage of the HMA at the SPS-1 project.
    a. ***ACTION ITEM:*** ***MDT will look for data on stripping on the MT LTPP sites included in the study factorial.***
    b. ***ACTION ITEM:*** ***The research team will prepare the individual site reports for each project in Montana and send them to MDT for review later this year or early next year – prior to the next meeting.***

8. During the presentations, it was emphasized that MDT will need to provide information and suggestions to some of the inputs based on their policies. These areas will be identified and provided to MDT in the future. MDT policy decisions regarding allowable distress and roughness need to be discussed.
    a. ***ACTION ITEM:*** ***The project team will prepare a listing of those items or inputs that will be influenced by policy decisions in MDT to complete the first full calibration.***

9. Design Guide glitches MDT needs to be aware of when using the software:
    - Top-down cracking model not calibrated. Harold recommended waiting until the results of NCHRP 1-42 become available. Right now, all load related cracking is being combined into one value for calibration purposes.
    - In rigid design the program remembers part of the calculations and a new trial design will take less time to run; this is not valid for asphalt pavements
    - Fatigue model for cement/fly-ash treated/stabilized materials does not work, the value of the modulus of rupture cannot be changed. Thus, the fatigue cracking model in the new M-E Pavement Design Guide software will not be calibrated until the error has been fixed. It was suggested that MDT send in a note to NCHRP that it be fixed so that they can continue with their local calibration efforts for the semi-rigid pavements.
    - Cracking is grossly over-predicted in flexible pavements with an asphalt permeable base layer; Harold suggested modeling the layer as an unbound material with a higher resilient modulus. This issue will be addressed in the user's manual provided to Montana, as a product from this study.

10. To use the simplified Excel spreadsheets in calibration, Harold suggested using EVERSTRESS for the linear elastic layer analysis. The program is available on the Washington DOT web site, for free. EVERSTRESS is the elastic layer program being used to calibrate the simplified performance evaluation-prediction tools that the Department can use for pavement management purposes.

11. It was mentioned that the simplified procedures for pavement design and performance predictions will be provided to MDT. However, no programming is planned for preparing code so that the models can be used in conjunction with MDT's pavement management program for projecting pavement rehabilitation projects. Calibration coefficients will be provided to MDT in using these tools, just as for the new M-E Pavement Design Guide. The same type of equations are being used for both activities.

12. MDT is encouraged to contact Harold, Dragos with any difficulties in using the Design Guide. Gregg Larson in the Illinois ERES office should be contacted for software/computer problems. Ed Harrigan (NCHRP) can also be contacted regarding any difficulties with the Guide. It is recommended that a carbon copy of any correspondence about problems with the software be sent to Dr. Edward Harrigan at NCHRP.

13. MDT advises Fugro to dispose of any material that was already tested and that does not require further testing. All other materials will be stored and possibly sent to NCAT for testing at a later time.

14. We will meet one more time after completion of all calibration activities and deliverables. The time of this meeting will be early next year – possibly during the NHI course on the Introduction to M-E Pavement Design. MDT is planning to host this course early next year. If they decide to host the course, the next meeting could be schedule during that time.